Testing the CVC Hypothesis in the β Decay of ^{14}O

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The A = 14 system offers an opportunity to test the Conserved Vector Current hypothesis of the electroweak interaction. CVC relates the width of an electromagnetic M1 transition in a nucleus with the shape factors of the beta decay spectra to the same nucleus from isospin analog states. This implication of CVC has been tested in the A=12 system by examining the shape factors of $^{12}B \rightarrow {}^{12}C$ and $^{12}N \rightarrow {}^{12}C$. However, the agreement with CVC is rather poor, and several experiments disagree.[1] The A = 14 system offers another CVC test with much larger shape factors. The shape factor is a deviation of the beta spectrum from the allowed-order shape by a factor $S(E) = 1 + aE$, where E is the total β energy.

We intend to measure the shape factor in the $0^+ \rightarrow 1^+$ branch of the positron decay of ^{14}O using a flat-field magnetic spectrometer with a multi-wire proportional chamber detector. Because the half-life of ^{14}O is only 71 seconds, it must be produced on-line using the 88" Cyclotron. To avoid systematic error in the spectrum from a thick source for the spectrometer, we intend to produce a beam of radioactive ^{14}O using a multicusp ion source developed by the LBNL Accelerator and Fusion Research Division. The ^{14}O will be produced by $^{12}C\,(^{3}He,\,n)^{14}O$ using a heated graphite target. The C-O gas evolving from the target will be transported in a closed gas line to the ion source on the cyclotron vault roof. The ionized ^{14}O will be implanted into a thin foil source at nearly uniform depth. Positrons from the implanted ^{14}O then enter the spectrometer. The ion source has been tested and has demonstrated low axial energy spread and good ionization efficiency for ^{16}O from CO.

The multiwire proportional chamber is currently being tested with the spectrometer magnet and off-line sources. We are currently installing the cusp source at the 88" Cyclotron, and we expect a run at the 88" in mid-March to test the production of ^{14}O and transport to the ion source. Gas transfer hardware and plumbing is being installed. We hope to measure the efficiency of the production, ionization, and implantation steps during the spring of 1998.

We also intend to measure the branching ratio of the superallowed $0^+ \rightarrow 0^+$ transition in ^{14}O. This branching ratio has been measured only once,[2] and is important for a precise measurement of the V_{ud} element in the CKM matrix. This would require a precise measurement of the entire energy spectrum at several spectrometer field settings to deconvolve the branches of the beta decay.

Footnotes and References

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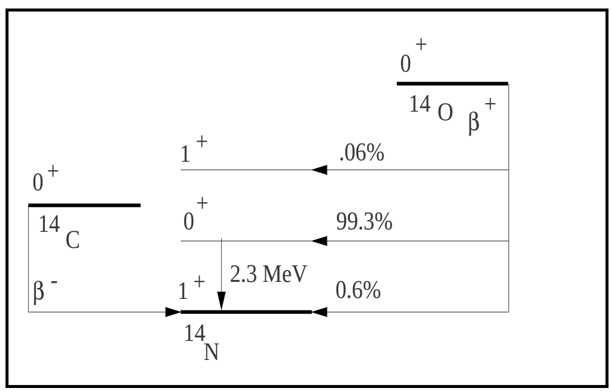

Fig. 1. The A=14 isospin triplet and decay scheme for ^{14}O decay. We will measure the spectral shape of the $0^+ \rightarrow 1^+$ transition and the branching ratio of the $0^+ \rightarrow 0^+$ transition.